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Oxygen Plasma Characterization Analysis for Plasma Etch Process

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Abstract – This paper is devoted to a study of the characterization of the plasma state. For the purpose of monitoring plasma condition, we experiment on reactive ion etching (RIE) process. Without actual etch process, generated oxygen plasma, measurement of plasma emission intensity.

Changing plasma process parameters, oxygen flow, RF power and chamber pressure have controlled. Using the optical emission spectroscopy (OES), we conform to the unique oxygen wavelength (777nm), the most powerful intensity region of the designated range. Increase of RF power and chamber pressure, emission intensity is increased. oxygen flow is not affect to emission intensity.

Key words – plasma, etch process, reactive ion etching, optical emission spectroscopy

I. Introduction

Plasma processing is an integral part of manufacturing, not only for the printed wiring board (PWB) industry, but also for the semiconductor industry and others [1]. Plasma treatment has been throughout industry for many process, including surface cleaning, roughening, activation, film deposit, patterning and etching [2]. OES is recommended as one of the diagnostics tool for plasma process. OES has been applied to continuous monitoring of plasma condition [3]. In-situ plasma monitoring using OES has advantages of non-intrusive and real-time. Historically the plasma treatment portion of many production procedures has proved difficult to predict and control. OES plasma diagnostics is typically based on the emission of plasma neutral, namely free radicals involved in the surface reaction as reactants or products [4].

II. Experiment

Figure 1. shows a use of the plasma etcher connect OES and computer monitoring system. This system is both capable for CCP- or ICP-RIE configuration, but CCP was investigated by setting 0W at

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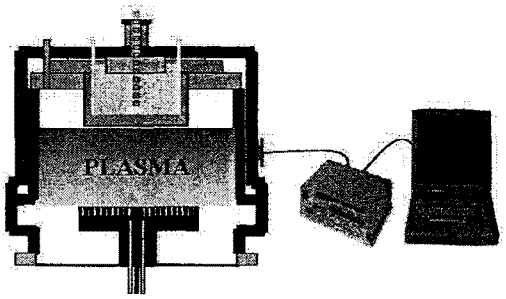

Figure 1. Plasma monitoring system

While the capacitively coupled plasma-reactive ion etch (CCP-RIE) was generated, optical emission spectroscopy system, mounted outside the view port, collected emission spectra. Plasma emission spectra scanned by OES was automatically stored in a local computer. In order to the analysis of plasma characterization, we selected three parameters, oxygen flow, RF power, and chamber pressure, were considered to change its value to see the sensitivity of the emission intensity along the modification.

Table 1. Baseline and the range of parametric change

	Oxygen flow	RF power	Chamber pressure
Baseline	25 sccm	300 W	50 mTorr
Range	5-50 sccm	150-450 W	40-60 mTorr
Step	5 sccm	30 W	10 mTorr

We have performed 9 to 11 experiments for each parameter, in total 30 experiments, and the baseline and the ranges of the modification is shown in Table 1.

III. Results

We have selected one specific wavelength corresponding to oxygen and the calculated the relative emission intensity measurement at some specific wavelengths can provide good information for the radicals inside the chamber, but their values tend to be arbitrary unless we use chemical actinometer with noble gas. Figure 2 and 3 clearly indicates that the emission intensity is linearly proportional to the change of RF power and Chamber pressure. Figure 4 shows that it is not affect to emission intensity. This is not surprising since the increased intensity can be explained by delivered power and amount of collision. What interesting fact in this experiment is that the average emission intensity collected over a period clearly shows the linear trend for both RF power and Chamber pressure. This is a good indicative that the average emission intensity can be readily utilized for detecting shifted process due to RF power and chamber pressure.

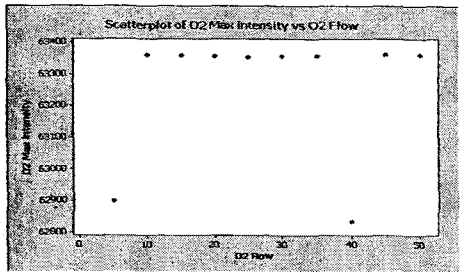

Figure 2. Emission intensity of changed oxygen flow.

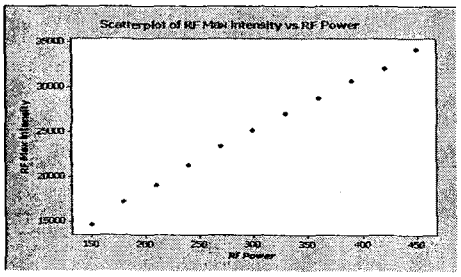

Figure 3. Emission intensity of changed RF power.

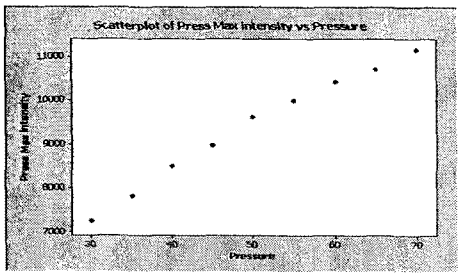

Figure 4. Emission intensity of changed chamber pressure.

Acknowledgement

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Reference

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